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| 10/724,787   | 12/01/2003  | Gianluca Paladini    | 2002P19673 US01     | 1913             |
| 7590<br>Siemens Corporation<br>Intellectual Property Department<br>170 Wood Avenue South<br>Iselin, NJ 08830 |             | 09/03/2010           |                     |                  |
| EXAMINER   |             |                      |                     |                  |
| RICHER, AARON M  |             |                      |                     |                  |
| ART UNIT   |             | PAPER NUMBER         |                     |                  |
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

# Office Action Summary

**Application No.**

10/724,787

**Applicant(s)**

PALADINI, GIANLUCA

**Examiner**

AARON M. RICHER

**Art Unit**

2628

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 29 June 2010.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-15 and 17-29 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 10 and 23 is/are allowed.
- 6) ☒ Claim(s) 1-7, 9, 11-15, 17-20, 22 and 24-29 is/are rejected.
- 7) ☒ Claim(s) 8 and 21 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: \_\_\_\_\_

**DETAILED ACTION**

***Response to Arguments***

1. Applicant's arguments filed June 29, 2010 have been fully considered but they are not persuasive.
2. As to claim 1, applicant argues that Smith discloses linear rays that are display raster lines, rather than rays cast as part of a volume rendering. However, col. 20, lines 62-66 of Smith state that the invention operates from a starting point and traces down 3D linear rays by applying dXdU, dYdU, dZdU as a horizontal raster line is *produced*. Smith is clearly discussing ray tracing in 3D, not simply rays that are one-dimensional raster lines. Also, Smith's reference to a horizontal raster line is referring to the display produced by the ray tracing method- Smith does not state the rays being traced *are* horizontal raster lines.
3. As to claim 28, applicant argues that Smith discloses generation of slice or sector images, rather than volume rendering, and that the use of a viewport is for slices, rather than rendering. Smith, however, states, at col. 26, lines 31-41 that slices are *retrieved* and dXdV, dYdV, dZdV parameters are applied to create points in a scan line, which continues until all lines have been *scan converted*, which completes scan conversion of a single viewport. What is being discussed here is the creation of scan lines for display (rendering) of a volume *using* the slices, not the creation of slices. Note that col. 26, lines 49-54 specifically discuss a mode of processing slices that is *useful for rendering* in some situations. In both cases, the slices are used for rendering rather than being

created. The ray tracing arguments with respect to claim 28 have been treated in the response regarding claim 1 above.

4. As to claims 5 and 18, applicant argues that Smith discloses selection of a sub-volume, but not volume rendering. As noted above, a volume is being rendered using ray-tracing and the acquired slices of Smith.

5. As to claims 6 and 19, applicant argues that averaging for interpolation is not alpha blending. Examiner recognizes that such averaging does not have to be alpha blending, but in this case does appear to be. Alpha blending involves the blending of pixel values into a single value using coefficients for each pixel value (known as alpha values) that represent how much that pixel should contribute to a final pixel value. Col. 20, lines 1-20 describe the blending of data points to determine a final rendering value, using coefficients for each value, thus reading on an alpha blending operation.

Applicant argues that only using 2 or 4 values for blending does not read on a threshold for blending, but the language of claim 6 only requires that the threshold limit a number of acquired ultrasound values such that scan conversion of other acquired ultrasound values is avoided. A limit of 2 or 4 acquired ultrasound values in a blending operation would appear to meet this limitation.

6. As to claim 11, applicant argues that Smith uses a dedicated scan converter, not a GPU. Examiner notes that the scan converter processes obtained ultrasound data into graphics data, and thus would appear to meet the definition of a graphics processing unit.

7. As to claim 12, applicant argues that one skilled in the art would not have used a flag and integer sum as a design choice in Park or Smith, noting that the flag and integer sum efficiently track visibility for the claimed reverse lookup. However, Park also discloses a lookup table for Cartesian-to-polar conversion and there is no reason to believe this combination of variables works more or less efficiently than any other combination of variables in such a table.
8. As to claim 27, the response above pertaining to claim 5 also applies.

***Claim Rejections - 35 USC § 103***

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claims 1, 3-6, 11-15, 17-19, 25, and 27-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith (U.S. Patent 6,241,675) in view of Park (U.S. Patent 6,192,164)
11. As to claim 1, Smith discloses a system for scan converting ultrasound data from an acquisition format comprising a polar format to a two-dimensional display format comprising a Cartesian format, the system comprising:
- a function having values corresponding to a spatial conversion from Cartesian coordinates of the Cartesian format to the polar coordinates of the polar format (col. 21, lines 3-11; VLSI circuitry is used to convert Cartesian raster points to polar format);

and a processor configured to identify acquired ultrasound data corresponding to the polar coordinates as a function of the values (col. 19, lines 51-66; ultrasound data is stored with respect to polar coordinates; col. 20, lines 1-42; this data is looked up using the polar coordinates converted from Cartesian),

the polar coordinates identified as a function of the values using the function for the spatial conversion from the Cartesian coordinates associated with a virtual volume free of voxel data (col. 20, line 56-col. 21, line 11; the Cartesian points are converted to polar; it is noted that since all of the actual ultrasound data is stored with respect to polar coordinates, the volume of Cartesian coordinates is not associated with the voxel data)

the processor operable to interpolate, in the polar format, from the identified acquired ultrasound data (col. 20, lines 1-42; the data is interpolated in the polar format and finally aligned to an x,y,z coordinate so it can be rasterized),

the interpolation being a function of three-dimensional rendering rays cast through the virtual volume (col. 20, line 56-col. 21, line 11; the interpolation is based on ray tracing in a Cartesian volume, the Cartesian points being converted to polar and then supplied to a filter for processing),

wherein the processor is configured to avoid scan conversion from the polar coordinates of volume data that does not contribute to a final volume rendered image by scan converting only visible voxels based on the rendering rays through the virtual volume and corresponding Cartesian coordinates (col. 20, line 56-col. 21, line 11; the scan conversion takes place using rays traced from raster points),

the identifying corresponding to identifying Cartesian coordinates associated with visible voxels of the final volume rendered image (col. 20, lines 35-46; the output data is rasterized points in a Cartesian grid; only data for the actual rasterized points is discussed as being processed).

Smith discusses lookup tables but does not expressly disclose a lookup table having values corresponding to a spatial conversion from Cartesian coordinates of the Cartesian format to the polar coordinates of the polar format. One example of a reference that achieves Cartesian-to-polar coordinate transformation through a lookup table is Park. Park discusses a lookup table for going from Cartesian coordinates to polar in an ultrasound system, with motivation being that it increases speed without raising cost of the overall system (col. 3, lines 42-60). It would have been obvious to one skilled in the art to modify Smith to use a lookup table for Cartesian-to-polar coordinate transformation in order to increase speed without increasing cost as taught by Park.

12. As to claim 3, Park discloses a system wherein the processor is operable to determine display coordinates of interest and identify the acquired ultrasound data by inputting the display coordinates of interest into the look-up table (col. 3, lines 42-60; col. 5, lines 32-58; ultrasound data is identified by inputting x,y display coordinates; since "coordinates of interest" is not further defined by the claim, any coordinates could read on these).

13. As to claim 4, Smith discloses a system wherein the acquired ultrasound data represents a scan volume in the acquisition format, wherein the processor is operable to

determine display coordinates for a plane through the volume as the display coordinates of interest (col. 26, lines 23-30; any slice through the plane can be specified);

further comprising a system comprising a display operable to display a two-dimensional image representing the plane in the display format with the interpolated values (col. 4, lines 46-53; the portion of the volume is displayed).

14. As to claim 5, Smith discloses a system wherein the acquired ultrasound data represents a scan volume in the acquisition format (col. 19, lines 52-67), wherein the processor is operable to determine display coordinates for the rays through the volume as the display coordinates of interest (col. 20, line 56-col. 21, line 11; the rays traced through the volume are used to produce the raster lines);

further comprising a display operable to display a two-dimensional image of a Volume Rendering of at least a portion of the scan volume in the display format with the display values (col. 4, lines 46-53; the portion of the volume is displayed).

15. As to claim 6, Smith discloses a system wherein each of the display values is a function of an alpha blending of a plurality of acquired ultrasound data values (col. 20, lines 1-20; inherently the cubic interpolation of values reads on an alpha blending; the interpolation coefficients can be seen as the alpha values) and wherein the processor is operable to limit a number of acquired ultrasound data values blended as a function of a threshold such that scan conversion of other acquired ultrasound data values is avoided (col. 20, lines 1-20; various thresholds of data values for interpolation are disclosed, including 2 and 4).



16. As to claim 11, Smith discloses a system wherein the processor comprises a GPU (fig. 2, element 235; a scan converter is employed to rasterize data, thus reading on a graphics processing unit).

17. As to claim 12, neither Smith nor Park discloses a system wherein the look-up table values each comprise a set of two fixed-point values, one Boolean Flag, and one Integer Sum, the two fixed-point values being Polar coordinates. These, however, are all arbitrary classes of variables and there is no disclosed criticality to them in applicant's specification. The choosing of these particular classes of variables appears to be a matter of design choice. One skilled in the art would expect the inventions of Smith and Park to work equally well with various other types of variables, such as integers, floating point variables, etc.

18. As to claim 13, Smith discloses setting clipping values and alpha values for blending when a set corresponds to a location outside a scanned region (col. 20, lines 23-35), but does not expressly disclose a system wherein a Boolean Flag indicates whether the set corresponds to a location outside of a scanned region. However, Official Notice has been taken of the fact that setting a flag for when data is in or out of a range is well-known in the art (see MPEP 2144.03). It would have been obvious to one skilled in the art to modify Smith and Park to set a variable when data is out of range in order to communicate this error to other parts of a computing system.

19. As to claim 14, see the rejection to claim 1.

20. As to claim 15, see the rejection to claim 1, in particular the parts dealing with the Park reference.

21. As to claim 17, see the rejection to claim 4. It is noted that the images generated would read on multi-planar reconstructions or MPR images since they are images comprising data from various planes of a volume.
22. As to claim 18, see the rejection to claim 5.
23. As to claim 19, see the rejection to claim 6.
24. As to claim 25, see the rejection to claim 13.
25. As to claim 27, Smith discloses a method further comprising: (d) Volume Rendering as a function of the display values as a function of time (col. 1, line 59-col. 2, line 18; various time-based views, such as a motion mode showing displacement over time, can be selected).
26. As to claim 28, see the rejection to claim 1. Claim 28 additionally recites that conversion from polar coordinates occurs without separate scan conversion and then rendering, which is also disclosed by Smith (col. 19, line 52-col. 21, line 11; the scan conversion and rendering happens in the same step; display values are directly determined using the x,y,z coordinates, rather than converting polar to Cartesian and *then* determining which values are actually displayed). Claim 28 further recites that scan conversion of different ultrasound values occurs for different observer locations, which is also disclosed by Smith (col. 26, lines 36-48; after one "viewport" has been rendered, a table is checked to see if others need to be rendered using different ultrasound values)
27. As to claim 29, see the rejection to claim 1.

28. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Smith in view of Park and further in view of Zar ("A Scan Conversion Engine for Standard B-Mode Ultrasonic Imaging").

29. As to claim 2, Park discloses values comprising polar coordinates and lookup table entries indexed by Cartesian coordinates, as noted in the rejection to claim 1, but does not expressly disclose a processor operable to bilinearly interpolate from the lookup table values using fractional offsets of Cartesian coordinates. Zar, however, discloses a bilinear interpolation using fraction offsets of Cartesian coordinates (p. 1, Introduction) to be able to convert to polar using a lookup table (p. 2, LUTs and Constant LUTs sections). The motivation for using this system is to accomplish scan conversion at a very low cost (p. 1, Abstract). It would have been obvious to one skilled in the art to modify Smith and Park to use bilinear interpolation and LUTs to convert polar to Cartesian coordinates in order to reduce cost as taught by Zar.

30. Claims 7 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith in view of Park and further in view of Drebin (U.S. Patent 4,835,712).

31. As to claim 7, neither Smith nor Park discloses a system comprising an RGBA look-up table addressed by the display values, the RGBA look-up table operable to output an RGBA value corresponding to the display value. Drebin, however, discloses a system that inputs monochrome display values to a lookup table and outputs RGBA values for those values (col. 7, lines 44-62). The motivation for this is to simulate an image illuminated by one or more sources of light (col. 2, lines 4-24). It would have been obvious to one skilled in the art to modify Smith and Park to use a lookup table to

convert between display values and RGBA values in order to simulate an image illuminated by one or more sources of light as taught by Drebin.

32. As to claim 20, see the rejection to claim 7.

33. Claims 9 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith in view of Park and further in view of Swerdloff (U.S. Patent 5,483,567).

34. As to claim 9, neither Smith nor Park discloses a system wherein the look-up table values correspond to the spatial conversion from the display format to the acquisition format for at least one acquisition plane; further comprising an additional look-up table corresponding to spatial conversion from the display format to the acquisition format across multiple acquisition planes. Swerdloff, however, discloses a system wherein a change in relationship between polar and Cartesian voxels, such as a change when changing an acquisition plane, necessitates creation of another lookup table (col. 9, lines 6-25). This is motivated by the fact that the current lookup table will no longer be accurate (col. 9, lines 19-25). It would have been obvious to one skilled in the art to modify Smith and Park to use an additional lookup table when multiple acquisition planes are used in order to have an accurate lookup table as taught by Swerdloff.

35. As to claim 22, see the rejection to claim 9.

36. Claims 24 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith in view of Park and further in view of Halmann (U.S. Patent 6,526,163).

37. As to claim 24, neither Smith nor Park discloses generating the look-up table as a function of a spatial relationship of a display format with user configured acquisition

parameters. Halmann, however, does disclose such a limitation (col. 7, lines 54-59; tables generated are dependent on a selected mode of operation; col. 3, lines 59-62 states that this mode is determined by a user and col. 5, line 51-58 states that the mode determines acquisition parameters). While not expressly disclosed by the reference, a common motivation for pre-calculating conversion tables is to speed up a system when image acquisition begins. Calculating only the necessary tables, as Halmann does would further speed setup times. It would have been obvious to one skilled in the art to modify Smith and Park to pre-calculate only necessary conversion tables to achieve greater efficiency as taught by Halmann.

38. As to claim 26, Park discloses a system wherein (d) comprises generating a two-dimensional look-up table with acquisition format coordinates for each coordinate of a Cartesian volume (col. 3, lines 43-65; a LUT with theta and radius values is calculated for each x,y coordinate).

### ***Conclusion***

39. Claims 10 and 23 are allowed.

40. Claims 8 and 21 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

41. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within

TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AARON M. RICHER whose telephone number is (571)272-7790. The examiner can normally be reached on weekdays from 8:30AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kee Tung can be reached on (571) 272-7794. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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Primary Examiner, Art Unit 2628  
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